

173-17055

ENVIRONMENTAL HEALTH PROGRAM IN NASA

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I plan to talk about the organization of the Environmental Health Program in NASA; the concept of functional management, some of our operational activities; and a little discussion on our more important problem areas in environmental health.

My concept in developing an environmental health program for NASA was to address our resources to the conservation of employees health and the environment from any factor which may be a hazard. An effective environmental health program will contribute to less absenteeism from injury and illness, better productivity and effectiveness, fewer claims for bodily impairments caused by various factors in the environment and a high degree of dedication and morale. Environmental health at NASA Headquarters is located in the Division of Occupational Medicine and Environmental Health, which is located in the Office of Administration under the NASA Administrator. The NASA policy on occupational medicine and environmental health is to utilize modern medical and environmental health concepts to, (1) determine the health status of employees, (2) prevent illness and promote good health among employees, and (3) identify and control factors that affect the health of personnel and quality of environment.

In terms of responsibility, field installation directors, by directive shall implement comprehensive medical and environmental health programs. The NASA Medical Director and the Chief of Environmental Health have the agency program authority and responsibility to ensure they are carried out effectively and in conformance with our standards and guides. In the NASA concept of administration, we are referred to as functional managers. By definition, a functional manager provides centralized professional leadership in a given area of specialization or discipline, such as safety, occupational medicine, environmental health, security, budget, and so on. Functional managers are responsible for recommending policy to the administrator, implementing policy decisions through operating practices and providing the Administrator with regular appraisals of overall agency performance and quality of effort. Functional managers have the authority to establish standards,

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procedures, and operating guides; review and advise on proposed allocations of personnel, funds and other resources; participate with headquarters and field officials in the selection of key personnel; conduct surveys, and reviews for the necessary evaluation of operating practices at headquarters and in the field.

We have approximately 15 NASA installations which are spread out over the country in the United States. These installations are engaged in activities ranging from research, laboratory oriented experiments, testing and launching. The scope of the health program applies to all of these areas. This slide will give you some idea of where our centers are located. I am sure most of you are familiar with a lot of these names as they appear on the map. Starting with the Goddard Space Flight Center, working your way down through Langley, and Kennedy, Marshall, Mississippi Test Facility, Flight Research Center on the West Coast, Jet Propulsion Laboratory, the Ames Research Center in San Francisco.

Environmental health, as we define it, is an applied science which is concerned with evaluating and controlling all the physical, chemical, radiological and biological factors surrounding an individual which may place upon him physiological or psychological stresses and impairment. It is also concerned with any factor which may affect the quality of the environment. This is fairly articulate, but the idea is that we are concerned with any factor which can have an effect on the health of the personnel or the quality of the environment.

Environmental health is composed of three basic disciplines; industrial hygiene; radiological health or health physics; and environmental sanitation, which is recognizing and controlling health hazards associated with the handling and distribution of food and potable water, sewage and industrial waste disposal, air and water pollution, solid waste and the storage and application of pesticides. The NASA environmental health program interfaces closely with occupational medicine, so that it is essential that personnel identified as risk regarding environmental health hazards are periodically monitored through specific health examinations, such as audiometry, chest X-rays, liver function tests, blood analysis and eye examinations, as the case may be.

Industrial hygienists, health physicists, and sanitation specialists are utilized singly or in combinations at NASA installations, depending on the extent of activities. In addition, analytical laboratory support is either provided or obtained, depending on the requirement. Unique specialty services are often obtained from other government agencies at a minimal expense. For instance, laser hazard surveys are provided

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by the U. S. Army Environmental Hygiene Agency at no fee, except travel expenses. I'll talk a little bit more about lasers later on in my talk.

Cross utilization of installation resources is encouraged and practiced. For example, the Goddard industrial hygienist provides consulting services and periodic visits to Wallops Station which is too small to justify a full-time industrial hygienist. Outside support to our program comes to us in the way of some consultants. We have Dave Sliney from the Army Environmental Hygiene Agency who is an expert on laser safety; Dick Chamberlin from M.I.T. who is a consultant on air pollution controls and fume hood ventilation. We receive direct support from the National Academy of Sciences, centers on toxicology and hearing and vision.

How do we remain cognizant of our existing and potential hazards? Well, there are various techniques. The following slide illustrates one that has been quite effective at our Marshall Space Flight Center in Alabama. I do not think you can see this too well, but essentially what we have done here is outline some of the areas on a location map by operations - e.g., manufacturing, quality assurance, aeronautic and astro type laboratories, technical services, test support areas and so forth. What they have done here is identify some of the existing or potential hazards and, of course, on this kind of a map they can conveniently determine surveillance scheduling. Of course, if anyone is identified as a risk, the information is cycled into the medical surveillance program.

Let me give you a sampling of some of the real situations which come under our surveillance at NASA centers.* This is a class 100 clean room. The "100" refers to the number of particles per cubic feet. In general, clean rooms will control particles in the .5 micron size range and up. In this slide they are attempting to detect solvent vapor concentrations encountered in propellant component cleaning. Solvents used include freon and other fluorinated and chlorinated hydrocarbons. You can tell by the configuration that this is a laminar flow type operation. There are a bank of high efficiency air filters on the left side and the air is recirculated back through the air filters into the air space.* This slide shows an industrial hygienist operating a velometer to determine the efficiency of the typical trichloroethylene bath ventilation system. In this case, the exhaust is either slot type or, possibly, push-pull. A typical medical follow-up on a trichloroethylene bath operator would be a periodic urinary biochemistry to

*Indicates use of a slide.

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detect the toxicity. Trichloroethylene can have a narcotic effect on the central nervous system. It can also produce liver damage.* This is a large paint spray booth for painting large components. The exhaust in this case is down through the grill work on either side as you can barely see there. The painters wear face respirators while operating primarily for protection against hazards of lead, esters, resins and various ketones.

*This is a set-up for painting the Saturn I-C booster at Marshall Space Flight Center. You will notice the small paint booths at both sides of the picture. These are exhausted to prevent overspray and the painters, of course, wear respiratory protection. This is nothing more than an operation showing the application of an epoxy using disposable gloves and a face respirator. Hazards in this case can be dermatitis from contact; and irritation, headache and nausea from respired resins and chemicals.

*This is a shot of the Saturn I test engine at Marshall. This particular test produced about 122 db at 15 hertz at a distance of 1200 feet. Observation galleries are approximately 2000 feet from the test stand and well protected from the hazard. This engine produces a million and one-half pounds of thrust and, of course, you know that five are used in the Saturn vehicle. Fuel is a combination of liquid oxygen and RP-1.

For the past year or so, I've had a staff assistant whose primary responsibility is radiological health protection. This is a health physicist by the name of Robert Alexander. Mr. Alexander has visited practically every one of our NASA installations and provided assistance on the effectiveness of the existing controls and also made recommendations for improvement where needed. Mr. Alexander is currently developing a NASA radiological health handbook which will describe uniform procedures for broad control programs for the agency. He will also speak to you later on the operational aspects of the overall NASA Radiological Health Protection Program.

We do have various radar facilities which are monitored for RF and radiation hazards. I won't go into any discussion on this except to say that conventional survey instruments are used and precautions are taken to ensure exclusion from hazardous RF energy. The X-radiation hazard from power amplifier tubes are monitored with an appropriate shielded instrument. Education of operators regarding radiation hazards interlocks, and so forth, is also included.

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*This is a shot of our radar facility at Grossman, North Carolina. This picture demonstrates the case with which an individual can place his head between the antenna feed and the sub reflector. The RF intensity of this region could vary from a minimum of one and one-half watts per square centimeter to a maximum of 150 watts per square centimeter. The levels would be an order of magnitude greater than those known to produce cataracts. Precautions taken here were: (1) Installation of interlocks to prevent radiation of RF beam below a 30° elevation; installation of warning lights on the dish which are automatically illuminated when a beam is radiated; and administrative SOP's advising personnel of hazards, and providing appropriate guidance, also the installation of warning signs.

*Environmental health is a prime consideration in the operation of the Neutral Buoyancy simulator at Marshall. Now the object of this simulator is to produce weightlessness so we can simulate the orbital workshops and various tasks in space, like using various wrenches. Breathing air delivered to divers in pressure suits in the tank is passed through a filter bank which you can see in this slide. The filter bank is primarily used to remove oils, scale, carbon monoxide and other impurities. The air is sampled repeatedly down-stream of the filters for total hydrocarbons, moisture content, carbon monoxide, and several other materials. In addition, the air is constantly monitored during use for oxygen content and carbon monoxide. Concentrations of oxygen and carbon monoxide above the preset limits on the respective detectors cause the alarm to be sounded.

Air for scuba bottles, emergency breathing lines, and the decompression chamber are applied from a high pressure tube trailer which is tested for breathability prior to being placed in service. Now, our experience so far, with this air has been extremely pure, and we haven't had much trouble with it. Water from the tank is sampled and analyzed periodically for the presence of harmful bacteria or fungus which is much the same as in a swimming pool.

*At Marshall we have an industrial waste treatment area which is almost complete. This area is designed to accept all liquid waste from the industrial sewer system. By a number of treatments, including dilution, settling, evaporation, neutralization, the wastes are rendered safe for release into the Tennessee River. Samples of the effluents are collected and analyzed to assure that concentrations do not exceed preset levels. Since we are on the subject of pollution, I thought I'd spend the next few minutes on our surveillance procedures using our Manned Spacecraft Center as an example.

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This is a slide of a location map at our Manned Spacecraft Center showing the various canals and ditches which are kind of outlined in red. We have sampling points set up for our canals, waste treatment plant outfall, the various ditches, cleaning shops, and an area for air particulates. Essentially what we are doing is selecting various sampling areas, and taking samples on a two week basis out of these canals and ditches and analyzing them in the laboratory. This is a shot of one of the industrial hygienists taking a sample out of the inlet canal coming from the Houston Lighting and Power Company containing cooling water. Actually this canal, by some geographic quirk, runs through the Manned Spacecraft Center. *This is also another one of the ditches or drainage areas that run through the Center where samples are collected. These samples are taken back to our laboratory and analyzed for BOD, solids, pH, phosphates, sulfates and chlorides. *This is a shot of the industrial hygienist checking the chlorine level at the waste treatment plant outfall. *This is a sampling device set up at the plating shop effluent. Here again this sample is checked for cyanides, chromium, pH; these are all done on a two week basis. *This is what we use for checking the community air at the installation. It is a high volume sampler with a fiberglass filter. It is run on a 24 hour test every two weeks; primarily checking for particulates. This is another shot of the sampler as it is being set up.

These are some shots of our environmental health laboratory at Houston. The procedures shown in these slides are:

- *1. Determining suspended solids in water
- *2. Visual titration analysis
- *3. Determining pH
- *4. Air analysis via chromatography
- *5. Water analysis via atomic absorption
- *6. Interpretation of infrared spectro photometric scan
- *7. Bacterial colony counting

In addition, a large portion of this laboratory effort is directed to the spacecraft sanitation support under the space medicine directorate.

The following slides will show you some of the elements connected with our pest control program at the Lewis Research Center in Cleveland. This is a shot of the area as it is secured for the storage of pesticides and our equipment. *This is just a shot showing some of the safety signs that are used during spray operations. *This is a picture of the inside of our pesticide storage van.

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*This shows the operators fixing the various pesticides. Putting the pesticides into the sprayer. *Here is a spraying operation of methoxychlor for adult mosquito control at the Center. *Notice the protective equipment, gloves and respirators. *Here is a shot of the operator applying a herbicide for broad leaf control at the Center. *This is a shot of the elaborate cleaning operation after the spraying. *Also, cleaning the protective clothing. *All operators are required to shower at the conclusion of our operations.

I'll talk a bit more about pest control a little later on, since we think pesticides are one of our special problems. I want to tell you about some steps we have taken to make sure we have a good effective program.

I would like to discuss some of our special environmental health programs at NASA and how we come to grips with them. I'll start with lasers. Laser, as you probably all know, is an acronym for light amplification by simulated emission of radiation. Within NASA there are approximately 300 lasers in operation. In case you are interested, we have something like 30 at Marshall, 50 at Langley, 40 at Electronics Research Center, 40 at Ames, 60 at Goddard, 30 at Jet Propulsion Laboratory and on down the line. Laser operations are mainly in four general areas: Space communications; optical radar; industrial applications; and tracking, and navigation. The primary hazards to the body appears to be the human eye, since the cornea and lens of the eye focus the laser beam on the retina and in so doing, concentrate the energy several times. Now this can produce retinal burns and lesions which can permanently impair vision. Personnel exposed to laser beams are furnished suitable protective eye wear of optical density adequate for the energy involved. *This is a picture of a laser goggle. Optical density is ten used at 6943 angstroms. This happens to be used for the ruby laser. Now, one of the things that we notice in our visits to NASA installations is that these glasses get intermixed and often the operator is not wearing the glasses with the right optical density and is not only unprotected but may very well take the unnecessary risks in viewing the direct or reflected beam. *This is a shot of an argon gas laser. You can see how you can complicate the hazard from the beam which can be redirected by the use of prisms. Of course, the redirected beam is just as hazardous as when it exits from the laser. So, these are some of the things you have to be careful about in your man/machine relationship. Another thing, too, you have to be careful about, is the various spectral surfaces you may have in the area of your operation. Because, here again, the reflected beam can be just as serious a hazard as the beam from the laser itself.

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*This just shows the internationally accepted symbol for the laser hazard.

Medical surveillance, generally, includes a preplacement eye examination, including a retinal photograph. Periodic eye examinations can then be compared to this baseline for pathological observation, as well as evidence in court cases involving claims against the government. Recognizing our limited resources, our approach to the potential laser hazard at NASA was to enlist the support of some nationally recognized experts who truly understood the laser hazard and could evaluate each operation from the concept of a man/machine system. The Army Environmental Hygiene Agency at Edgewood Arsenal appeared to have excellent credentials along this line, and in particular, an outstanding young physicist by the name of Dave Sliney, who was enlisted as a consultant of our program. Mr. Sliney, at our invitation, conducted surveys at our Manned Spacecraft Center, Marshall, Goddard, Ames Research Center, Langley, and Lewis. Mr. Sliney's report, impacts primarily on hazard conditions and recommendations for each laser operation. In addition, guidance is offered on the basic precaution, looking into the beam, and expected reflections. This should be avoided, of course. His report also contains criteria for selecting appropriate eye wear. We have just prepared a NASA standard on the control of health hazards from laser radiation and this should be published in the next month or so. A couple of the important features in this standard are that we are requiring registration of all lasers with our environmental health department at NASA installations; secondly, there will be a preoperation approval and certification required by environmental health officials.

Another item that has been emerging as a concern for health hazards are microwave ovens. Microwave ovens are used primarily for rapid heating and cooking of foods. Electromagnetic radiation of this type may be harmful to some parts of the human body, such as the eyes, if exposed to radiation levels significantly in excess of the recommended threshold levels of 10 milliwatts per square centimeter. About a year ago, we alerted NASA installations to this potential hazard and recommended that all microwave ovens be surveyed periodically for radiation leakage. Overall count of these ovens in NASA is approximately 75. Our experience has been that approximately 20 percent of these ovens have, at one time or another, exceeded the permissible exposure level. Primary reason for leakage has usually been defective door gaskets, hinges and latches.

Most of these ovens have been provided through vendors who have been very cooperative in repairing or replacing ovens as required. For

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the most part, these ovens are now surveyed on the basis of once every two months. We feel that the potential microwave oven hazard is under good control in NASA. One area that needs improving is the notification problem between the parties responsible for putting the ovens in service and health officials responsible for hazard surveillance. Steps are being taken to eliminate this problem with an agency standard on the subject of microwave ovens which is in preparation at this time.

The other subject I mentioned earlier is that of pesticides. We are obviously concerned about this, not only from the standpoint of hazards as it presents itself to people, but also from the pollution aspect. Pesticides are chemical substances used to kill pests. Pests may be weeds, insects, rats, mice, algae, worms and any other destructive form of life. Improperly used, poisonous pesticides can and do cause illness, even death, to human beings. Within NASA, every installation has some form of a pesticide control program with the exception of Electronics Research Center and NASA Headquarters which rely on another government activity. The majority of these programs are executed through contractors, like professional exterminators. We ask each NASA installation on an annual basis to report on their upcoming pesticide activities, highlighting the objective, pesticides to be used, rate of application and method of application. Now these data, once compiled, are referred to the Federal Committee on Pest Control, with whom we meet annually to review the total program to correct any problems before they occur. This year, we have asked for specific guidance on the continued use of DDT and other hard pesticides. We have advised our installations to substitute something less toxic where possible. In addition, we encourage all centers to contact us on any special problems as they arise. Our environmental health personnel at the installation concern themselves with storage, application and handling of pesticides, as well as periodic physical examinations.

Another problem area that we looked at very carefully has to do with beryllium. We do have some industrial operations within NASA involving beryllium. As you know, beryllium is an extremely desirable metal because of its light weight, durability, and heat resistance. The machining operations at Marshall is the largest industrial facility in NASA. Industrial hygiene controls in effect are considered very effective. These chips and particles, as you can see, are captured at the point of generation and passed through a high efficiency filter before the air is exhausted to the outside. Protective clothing is provided to employees and laundered separately on the premises. Air samples are taken in-plant and off-plant at periodic intervals and the

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air filters are buried at a remote site. The TLV for beryllium (in plant) or two micrograms per cubic meter and (off plant) .01 micrograms per cubic meter are strictly observed.

*At this particular facility, we have six people working there. Beryllium takes up less than 50 percent of the facility activity and we have a laundry located at the facility, as I mentioned earlier. *The ventilation is of a high velocity, low volume type. The air samples, as they are collected, are referred to an analytical laboratory at Marshall for spectrographic analysis and the waste filter is packed in an airtight polyethylene bag and buried in a sanitary fill. This appears to be a preferred method of disposal at this time. There are not enough beryllium chips in the filters to make reclamation economical. These machine workers get medical lab tests, blood, urine, and chest X-rays every six months and, in addition, an annual physical exam. Now, another application of beryllium at NASA is in the area of propellant additives. The use of beryllium in rocket motor fuel offers a significant increase in performance and is thereby being explored for upper stage use. Our role is to provide advice to the NASA project office on the industrial hygiene and medical considerations. Just recently, a 3000 pound, ten percent beryllium motor was test-fired by a NASA contractor on the Air Force Western Test Range Facility at Eniwetok. Preliminary results indicated that all criteria, such as air quantity, surface contamination, and soil content were satisfied.

Some of the basic guides that we provide are: (1) Concern must be exercised for the protection of people; the prevention of pollution to the surface and ground water or soil; damage to plant life and harm to animals. (2) From the standpoint of background data, analyses should be made of prefiring and postfiring soil samples for beryllium concentrations at the points of air sampling. The prefiring sampling should be taken at the time air samples are activated and the post-firing samples taken at the time the air samples are picked up. This pick-up must not be made before the entire cloud has passed by and settling out has stopped. (3) In-plant, atmospheric beryllium levels should not exceed two micrograms per cubic meter as I mentioned earlier, time-weighted on a daily basis. Off-plant or neighborhood concentrations at the breathing zone level should not exceed .01 microgram per cubic meter checked on a daily basis. In the prediction formula for computing downwind exclusion radii for beryllium propellant combustion cloud, the latest Public Health Service air quality criteria of 75 microgram minutes per cubic meter within the limits of 10 to 60 minutes must be used. Surface contamination shall not exceed 25 micrograms beryllium per square foot and soil contamination levels shall be set at 100 micrograms

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beryllium per gram of soil. Where personal respiratory protection is required, it is recommended that the MSA Comfo with Type H filter or something comparable be used. These respirators should be worn in required areas during the operation until it is established that the TLV level has not been exceeded. Other criteria covers the selection of high volume samplers, filters, analytical requirements, breathing zone samplers and medical monitoring.

If I can leave those topics for a minute, I would like to talk for just a few minutes about an important dimension to our NASA safety and health program in the area of application of NASA contractors. The NASA procurement regulations contain a recently updated directive which covers safety and health as referred to in subpart 52. This subpart sets forth the policy, responsibility, and requirements related to NASA safety and health programs with regard to its contractors. It is NASA's policy that contractors and subcontractors undertake performance of the safety and health conscious environment which, within the limits of controllable hazards, will; protect the life, health and physical well-being of NASA contractor employees doing their work on NASA programs; assure proper protection to the public; avoid accidental work interruptions; prevent contamination of property, supplies and equipment; and provide data whereby risks and loss factors in space technology related to the programs can be accumulated and evaluated. It is basically the responsibility of the originator of a NASA procurement request to determine to what extent a contractor safety and health plan will be required. He does this on the nature of the procurement and by conferring with appropriate safety and health officials at the installation. Safety and health officials will advise the contractor in; determining to what extent safety and health provisions, if any, should be included in the proposed procurement; electing the specific safety and health provisions to be included in the contract schedule; determining adequacy of contractor safety and health plans; and determining the extent and form of accident/incident reports. The contracting officer will obtain the advice, assistance, and recommendations of the safety and health officers prior to the issuance of an invitation to bid or request for proposal in the following procurements; booster and engines, transportation of fuels, oxidizers and other hazardous materials; research, development, or test of engines; operations which involve health hazards or the use of a hazardous material, including potential contamination to property, pollution of air, water, vegetation, soil; and adverse alteration of the work environment by activities concerned with ionizing radiation, microwave, noise, lasers, and any other direct or secondary effect.

The clause may be excluded from any contract which is subject to either the Walsh-Healey Public Contracts Act or the Services Act of 1965 in which the application of either act constitutes adequate safety and health protection. Basically, the clause has provisions for a safety and health

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plan to be submitted for the contracting officer's approval; reporting of accidents and incidents; non-compliance notification of stop work when required; application of the clause on subcontractors and suppliers; and finally, the authorization of NASA representatives to examine contractor work sites for adequacy of safety and health measures.

This updated clause has been in effect about two or three months. Some of our recent visits to the centers indicate that it is working. We know that some of our people have been meeting with the contracting officers determining where we need some special information in the contract schedule which is not covered by the Walsh-Healey Act.

I will close this presentation by showing a short film (10 minutes) on the subject of environmental health which was produced by Charles McHenry, Industrial Hygienist at Xerox Corporation. This film has been very useful in presenting the environmental health program to management in a very meaningful and productive manner.